Amendments to the Specification:

Please amend the paragraph beginning on page 1, line 5 as follows:

The invention relates to printing of electronic documents, and in particular to printing of documents that include ~~bar-codes~~ barcodes. The invention also relates to a computer readable medium that contains an electronic document and a document processor that contains such an electronic document.

Please amend the paragraphs beginning on page 2, line 1 through page 5, line 15 as follows:

Some electronic documents include ~~bar-codes~~ barcodes to facilitate processing of the printed version of the documents. ~~Bar-codes~~ Barcodes are of course well known per se and include not only extremely familiar ~~bar-codes~~ barcodes made up of vertical bars in ink against an uninked background, but also other dedicated standardized machine readable patterns of geometrical elements such as configurations of inked polygons (in particular rectangles or hexagons) against a background. In this sense the term ~~bar-code~~ barcode, as also used herein, is not limited to codes made up of bars, but extend to any printed geometrical pattern for standardized machine encoding and decoding. In particular, ~~bar-codes~~ barcodes ensure that the process of data capture from the printed documents will later take considerably less work.

It is not difficult to add a static ~~bar-code~~ barcode at the time of authoring. Any static ~~bar code~~ barcode can be added by including picture data that defines a bit map of the ~~bar-code~~ barcode. It would be desirable that ~~bar-codes~~ barcodes could also be printed dependent on data that has been entered by the user into the fields in a form, preferably in addition to rendering in

normal human readable characters. In this case it is desirable to generate the ~~bar code~~ barcode at the document processor, once the form is filled.

In one implementation, this can be realized by a making use of an installed ~~bar code~~ barcode generation library at the user computer and including function calls to this library in the electronic document to generate ~~bar codes~~ barcodes. However, this makes the distribution of electronic documents dependent on installed programs. The author of the document has no control over these programs. Electronic documents may thus have different effects on different user computers, or may not even work at all when no library is installed.

Another implementation uses a ~~bar code~~ barcode "font" that defines ~~bar code~~ barcode symbols assigned to respective characters. The author of a form ensures printing of a ~~bar code~~ barcode by specifying that data entered in a field should be printed using the ~~bar code~~ barcode font instead of conventional digits.

When the necessary font is not installed on a computer, problems arise when the document has to be printed. More generally, the use of commands to print a string of characters with a specific font is an inflexible solution, which limits the kind of ~~bar codes~~ barcodes that can be printed. Other than by supplying different characters the generated ~~bar code~~ barcode cannot be adapted to make the ~~bar code~~ barcode document or user specific.

These problems can partly be solved by embedding a ~~bar code~~ barcode font definition in the electronic document. The font definition in the document defines a closed collection of geometrical shapes, one for each possible character, that should be printed to render respective characters. However, this solution still does not overcome all problems associated with fonts. Some two dimensional ~~bar codes~~ barcodes cannot even be printed at all as characters printed with a font. For example, some two dimensional ~~bar codes~~ barcodes define a two dimensional

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matrix of positions where spatial blocks must be printed to represent bits of codewords that are derived by compacting characters. The bit positions for a codeword form a respective spatial block in the printed document, but the blocks need not all be arranged in rows or columns, and may even not be rectangular. Such an arrangement of blocks cannot be printed by printing the blocks font symbols selected by successive characters. Moreover, printing with a font does not support computations that are useful for character encoding, such as compaction and generation of error correction symbols, Also, the same geometrical shape must always be used for the same character.

An additional problem is that unscrupulous persons might attempt to tamper with the printed document, so that false data will be captured when the ~~bar code~~ barcode is captured, by physically replacing a ~~bar code~~ barcode of a document with a different ~~bar code~~ barcode that is not consistent with the information printed with human readable characters. Such a false ~~bar code~~ barcode can easily be generated when a commonly available standard ~~bar code~~ barcode font is used to generate the ~~bar codes~~ barcodes in a document.

Among others, it is an object of the invention to enable printing of electronic forms with ~~bar codes~~ barcodes that encode user defined data, in which the ~~bar codes~~ barcodes can be generated more flexibly.

Among others, it is an object of the invention to enable generation of ~~bar codes~~ dependent on user defined data without having to rely on pre-installed modules in a user computer such as fonts or libraries.

Among others, it is a further object of the invention to take measures against tampering with ~~bar codes~~ bar codes in a printed version of an electronic form.

Among others, it is a further object of the invention to make it possible to include any kind of two dimensional ~~bar-code~~ barcode that encodes user entered data in a printed version of an electronic form.

Among others, it is a further object of the invention to make it possible to include ~~bar codes~~ barcodes, without needing to embed a font definition in the electronic form.

The invention provides for a method of obtaining printed instances of a document. According to the invention the document contains an embedded program, for controlling printing of geometrical elements of a ~~bar-code~~ bar code in an instance of the document, dependent on user data entered in an input field in the document. The embedded program is linked to the user data input field in the sense that, when the document is printed the program will be called with the string from the field as argument; thus there is preferably a freedom to choose the program that is linked to a field. Different programs may be linked to different fields, or the same program could be linked to different fields.

Each program uses codewords, which are numerical values that each represent a respective character that has been entered in the field, or compactions of the characters, or error correction codewords derived from the characters etc The ~~bar-code~~ barcode in the printed document is made up of a number of different areas, each containing a configuration of geometrical elements, each configuration representing a respective codeword, in the sense that after scanning the barcode each of the codewords can be decoded from a respective configuration of all printed geometrical elements and the background in a respective one of the areas. The program generates commands to print individual geometrical elements of configurations of elements that, as a configuration, represent a codeword in the respective area of the ~~bar-code~~ barcode. The geometrical elements are for example polygons (e.g. rectangles or hexagons) for

which printing commands exist for on the printer, so that the printer does not need to support specific commands for printing ~~bar-codes~~ barcodes, and the generated commands each command printing one such general purpose geometrical element.

Please amend the paragraphs beginning on page 5, line 25 through page 7, line 23 as follows:

Because the program is embedded in the electronic form (i.e. the program travels with the document and does not need to be installed separately) a general purpose viewer may be used, which is not specifically prepared to generate ~~bar-codes~~ barcodes or even two-dimensional ~~bar codes~~ barcodes. An Adobe Acrobat (R) viewer may be used, for example.

Any kind of two dimensional ~~bar-code~~ barcode may be drawn in this way, including for example ~~bar-codes~~ barcodes that use a map of differently shaped areas within the ~~bar-code~~ barcode, wherein each area represents a respective codeword and contains a configuration of all geometrical elements and the background that represent the codeword with the particular shape of the area. Similarly an area in which a codeword is represented may contain disjoint parts that are separated by areas in which other codewords are represented.

The embedded program controls all the properties of the printed geometrical elements that, together, form the printed ~~bar-code~~ barcode. Because an embedded program is used, the configurations of geometric elements of the ~~bar-code~~ barcode can be flexibly adapted in ways that will not affect the result of decoding of the ~~bar-code~~ barcode, in so far as the ~~bar-code~~ barcode is decoded according to the standard that defines the ~~bar-code~~ barcode. The adaptations can be used to communicate additional visual information by means of the ~~bar-code~~ barcode, so that the additional visual information is preferably prima facie recognizable for humans (i.e. without having to decode the ~~bar-code~~ barcode, and if desired irrespective of the codewords).

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The additional information may include information that makes it difficult to replace the ~~bar code~~ barcode unnoticeably in a printed document. The additional information may also include information that represents a company logo, for example. Preferably, the embedded program is arranged to make adaptations to the ~~bar code~~ barcode so that different geometrical elements within the same area (which contains all geometrical elements and their background that represent a codeword and no geometrical elements or background that represent other codewords from the ~~bar code~~ barcode) can be adapted independently.

The adaptations may involve adding geometrical elements for use in the printed the ~~bar code~~ barcode, so that the added elements are recognizable by themselves when printed, for example because they are in a different color from other elements of the ~~bar code~~ barcode, or so that the added elements are recognizable in combination with elements that are added to the printed document outside the ~~bar code~~ barcode, for example as the extension of lines added to the printed document. The adaptations may also involve changing the color or grey level density of selected geometrical elements of the ~~bar codes~~ barcodes. The adaptations may also involve removing geometrical elements of the ~~bar codes~~ barcodes altogether, if the removal can be corrected by an error correction mechanism defined for the ~~bar code~~ barcode. The adaptations may also involve to modify certain geometrical elements from a ~~bar code~~ barcode so that a geometrical element of a first ~~bar code~~ barcode is formed by a second ~~bar code~~ barcode (encoding another string of characters), preferably of a different type, without affecting later decoding of any of the first or second barcode, creating the concept of "sub barcode in barcode".

The invention also provides for an electronic form that contains an embedded program of machine executable instructions to control drawing of elements of a ~~bar code~~ barcode in a printed version of the electronic form, dependent on data entered by a user into fields of the electronic form. With such a form the user is enabled to fill in the data to be represented by the

~~bar-code~~ barcode interactively using a document viewer, without being permitted to edit the document in its entirety. Such electronic forms can be distributed as messages via the Internet or on data carriers such as magnetic or optical disks.

The invention also provides for a method for authoring an electronic form by editing an embedded program for generating ~~bar-codes~~ barcodes, so that effectively the ~~bar-code~~ barcode is authored to make it user defined data or even document specific, within the restrictions imposed by decodability.

Please amend the paragraphs beginning on page 7, line 27 through page 8, line 7 as follows:

These and other objects and advantages aspects of the invention will be illustrated using the following figures

FIG. 1 shows a document processing system

FIG. 2 shows a printed form

FIG. 3 shows a flow chart

FIG. 4 shows a further printed form

FIG. 5 shows a ~~bar-code~~ barcode

FIG. 6 shows a ~~bar-code~~ barcode

FIG. 7 shows a ~~bar-code~~ barcode

Please amend the paragraph beginning on page 8, line 22 as follows:

FIG. 2 shows a typical printed document page 20. Page 20 contains lines of text 21, whose content is determined by the electronic document data Page 20 also contains a field 22

whose content is at least partly controlled by user input information entered by a user on input terminal 16 (more than one such field may be present). Furthermore, page 20 contains ~~bar-code~~ barcode area 24 whose content is also at least partly controlled by the user input information

Please amend the paragraph beginning on page 9, line 18 as follows:

Furthermore, the instructions include third instructions that define what commands have to be generated for printer 16 to draw a ~~bar-code~~ barcode responsive to user input information. The ~~bar-code~~ barcode may conform to any standard bar code definition. A well known ~~bar-code~~ barcode standard, for example, defines ~~bar-codes~~ barcodes made up of a series of successive groups vertical dark bars alternating with lighter bars. Each group encodes a character. The widths of the bars in each group are selected dependent on the encoded character. Other ~~bar codes~~ barcodes include standards that define two dimensional ~~bar-codes~~ barcodes made up of a collection of light and dark polygons at positions determined by the encoded codewords, or a collection of lines at angles selected dependent on the encoded information etc. It should be noted that the words "~~bar-code~~ barcode ", as used herein, covers all these standards and has a generalized sense of any standardized system of printed machine interpretable elements, not limited to the use of vertical bars.

Please amend the paragraphs beginning on page 10, line 7 through page 11, line 4 as follows:

FIG. 3 shows a flow chart of the process executed by document processor 14 under direction of the third instructions. In a first step 31 the third instructions instruct document processor 14 to supply the user input information that affects the ~~bar-code~~ barcode, typically in the form of a string of character information (representing, for example, a number entered by the

user). Optionally, additional information that affects the ~~bar code~~ barcode is supplied, the additional information being derived from the electronic document data as transmitted

In a second step 32, the third instructions instruct document processor 14 to encode the user input information and the optional additional information into a list of codewords that has to be represented in the ~~bar code~~ barcode. Encoding involves for example compacting combinations of characters from different positions in the string into codewords, and adding error detection and/or correction codewords.

Please amend the paragraph beginning on page 11, line 8 as follows:

In a fourth step 34 the instructions instruct document processor 14 to generate commands for printer 18 to draw basic geometric shapes (such as rectangles or hexagons) with specified color, height and width at a specified position in a configuration of geometric shapes that represents this codeword in an area of the ~~bar code~~ barcode in the printed document, in the sense that the codeword can be decoded from the geometrical elements and their background in the area. The location and optionally the shape of the area is determined by the position of the codeword in the list. The third instructions instruct document processor 14 to generate a plurality of commands to print the ~~bar code~~ barcode in terms of a plurality of geometric elements that represent the codewords in a specified configuration (Note that a geometric element, as used herein, is not a whole ~~bar code~~ barcode configuration that represents a codeword, but merely one of a number of elements of a basictype (such as rectangles or hexagons) from which any ~~bar code~~ barcode is composed).

Please amend the paragraphs beginning on page 12, line 4 as follows:

At the end of the fourth step 34 document processor 14 removes the selected codeword from the list of codewords that has to be processed and returns to third step 33. It should be appreciated that, in case of a linear ~~bar-code~~ barcode, the commands preferably control printer 18 to draw bar codes from successive codewords from the list which are at geometrically linearly successive positions in the ~~bar-code~~ barcode area. However, the sequence of the commands may differ from the geometrical sequence. In particular in case of a two dimensional ~~bar-code~~ barcode a random sequence, not determined by the geometrical position may be used.

Please amend the paragraphs beginning on page 12, line 18 through page 15, line 8 as follows:

The third instructions are adapted to create the configurations in the printed information in ~~bar-code~~ barcode area 24 dependent on the particular area. That is, the same codeword will cause the embedded program to generate commands to print different configurations, dependent on whether the codeword is represented in one area or another, not just the same configuration translated to another area.

The dependence on the area can take different forms. In one embodiment the configuration is adapted differently in different areas in a way that does not affect the information that can be retrieved from ~~bar-code~~ barcode area 24 when the ~~bar-code~~ barcode is decoded according to its standard definition. This may be used for example to make it difficult for unscrupulous persons change the ~~bar-code~~ barcode after the document has been printed. Another application is the addition of human noticeable information to the ~~bar-code~~ barcode without altering the information that will be decoded when the ~~bar-code~~ barcode is read according to its standard definition, for example by adding a simple logo etc.

For example, most ~~bar-code~~ barcode standards do not specify the colors that should be used for encoding the ~~bar-codes~~ barcodes, or specify only a range within which a contrast between different colors should lie (or the range of any other parameter). In the further embodiment the third instructions direct document processor 14 to vary the color of individual geometrical elements of the ~~bar-code~~ barcode dependent on information from the electronic document and/or user input information at predetermined positions in the ~~bar-code~~ barcode so that this does not affect the information that will result when the ~~bar-code~~ barcode is decoded.

As another example, most ~~bar-code~~ barcode standards provide for decoders that work properly even if there are some meaningless lines in the ~~bar-code~~ barcode or if elements of the ~~bar-code~~ barcode have been obliterated, or printed unsharply. This is compensated for by error correction techniques, or optical techniques. In an alternative embodiment the third instructions direct document processor 14 to or add or remove elements in the ~~bar-code~~ barcode in the printed document, or print selected elements as composites of smaller elements, that are selected independent of the string that is encoded in the ~~bar-code~~ barcode, but dependent on other information from the electronic document, so that this does not affect the information that will result when the ~~bar-code~~ barcode is decoded.

FIG. 4 shows an example of a printed document that has been adapted in this way. In this example the third instructions have caused lines 40 to be drawn that extend over part of the text and over the ~~bar-code~~ barcode area. The angles of orientation of the lines are selected specific to the printed document, for example at random or dependent on the user input information. Thus, when an unscrupulous person replaces the ~~bar-code~~ barcode by another ~~bar-code~~ barcode with lines at a different angle this will be immediately noticeable.

FIG. 5 shows a two dimensional ~~bar-code~~ barcode in which some elements have been removed. The ~~bar-code~~ barcode will be decoded according to a ~~bar-code~~ barcode standard that normally defines the generation of ~~bar-codes~~ barcodes in terms of a set of configurations, each for representing a different codeword, that does not include any configuration with a white horizontal line in it. It is assumed that this standard provides for correction of errors, including some errors that result in a white line. According to an aspect of the invention the third instructions have caused an area 50 with a white line to be created in the ~~bar-code~~ barcode at a predetermined position, which thus does not conform to the standard, but can still be read. A human observer could verify that a ~~bar-code~~ barcode particular to the input field is present in the printed form by verifying the presence of the whiteline. Similarly, elsewhere in the barcode a black line has been created.

FIG. 6 shows a two dimensional ~~bar-code~~ barcode in which the geometrical elements of a human readable word has been printed in the region occupied by the geometrical elements of the ~~bar-code~~ barcode. Again it is assumed that the ~~bar-code~~ barcode standard provides for correction of any errors induced by the presence of the word.

As an another application color differences may be introduced between geometrical elements that are treated as equal during decoding. For example, all geometrical elements in a horizontal rectangle that runs across a two-dimensional ~~bar-code~~ barcode may be given a color that differs from the color (or colors) of geometrical elements outside the rectangle. In a one dimensional ~~bar-code~~ barcode, similarly, the vertical bars that make up the ~~bar-code~~ barcode may each be printed as a composition of blocks of different colors. Thus a human readable message can be included in the ~~bar-code~~ barcode. It should be appreciated that the polygons that receive different colors may be selected as needed for the message, independent of the codeword that is

represented different polygons in a part of the bar code that represents one codeword may receive different colors.

FIG. 8 7 shows two ~~bar codes~~ barcodes a first ~~bar code~~ barcode comprises vertical bars, and one of the bars forms a second ~~bar code~~ barcode. The ~~bar codes~~ barcodes are arranged so that both the first and the second ~~bar code~~ barcode can be decoded. In this case, when the embedded program generates commands to print the first ~~bar code~~ barcode, the embedded program has to generate a command to print the one bar with a certain width, the embedded program adapts the commands used for printing this one bar dependent on the information that has to be represented in the second ~~bar code~~ barcode. It will be appreciated that more than one of the bars of the first ~~bar code~~ barcode may be treated in this way.

It will be appreciated that many other kinds of modifications of the ~~bar codes~~ barcodes are possible that do not affect the information that will be decoded when the ~~bar code~~ barcode is read.

Please amend the paragraphs beginning on page 16, line 1 through page 18, line 18 as follows:

S1, S2 etc. are constants that correspond to the different codeword values that can be represented; R11, R12, R13, . . . are constants that represent the offset values of the different geometric elements that represent the codeword, relative to the location of the ~~bar code~~ barcode area.

In this example additional information is supplied in addition to the codeword that is represented. The additional information parameter is used to modify the ~~bar code~~ barcode in a way that does not affect later decoding of the barcode. In the example, a function "drawElement"

is called a number of times. Each call has a location as argument to ensure that calls for a predetermined configuration of elements are executed, relative to a location of the ~~bar-code~~ barcode. The calls depend on the codeword that is represented, but are executed irrespective of the additional information, which is passed as an argument in the calls. An example of the implementation of drawElement is

3 function drawElement(location, additionalInformation) { if (overlap(location, additionalInformation)) issue("setColor RED"); else issue("setColor BLACK"); end if issue("moveTo"+location); issue("printRectangle W, H"); }

The function drawElement issues commands "setColor", "moveTo" and "printRectangle" to the printer, which command printing of a rectangle with a certain width and height, color and position (in other examples hexagons might be used instead of rectangles). In the example, the issued setColor command depends on the additional information: when the location at which the rectangle is to be drawn overlaps an area specified by the additional information a command to set the color to red is issued to the printer; otherwise a command is issued to set the color to black (the function "overlap" tests for this condition). It is assumed here that switching from red to black does not affect later decoding of the ~~bar-code~~ barcode.

It should be appreciated that the described program is merely an example. Similarly, the printer commands are shown by way of example only; any appropriate type of printer command may be used. Without deviating from the invention other programs may be used, in which the same or a different effect may be realized in another way. For example, commands to print certain rectangles at certain locations may be suppressed altogether, or commands to print additional rectangles may be added. In case of a two dimensional ~~bar-code~~ barcode, the selection of the configuration (performed by the "if statements" in the function for representing the

codewords) may depend on the position where the codeword is represented in the ~~bar code~~ <u>barcode</u>, as specified for example by the additional parameters.

Furthermore, although an embodiment of the invention has been described using network 12 between document server 10 and document processor 14 to transport the electronic document data as an internet message signal, it will be clear that other means of transport may be used, for example by providing the electronic document data on a disk, such as a floppy disk or an optical disk such as a CDROM. Similarly, although a local printer 18 has been shown, it should be understood that document processor 14 may in fact produce a further electronic document, which includes the ~~bar code~~ <u>barcode</u>, for later printing at any convenient place and time.

Preferably, the document authoring program that the author uses to create the document provides for assembly of the embedded program in such a way that the author can adapt the ~~bar code~~ <u>barcode</u> generation to the document, so that a document specific ~~bar code~~ <u>barcode</u> is generated. For this purpose a set of building blocks programs may be provided that the author can use to assemble the embedded program when authoring the document, using for example a conventional text editor. Thus, in the example above, the functions drawBarcodeCodeword and drawelement could be provided as building blocks, the author programming in the embedded program with what argument "additionalInformation" the function drawBarcodeCodeword will be called for a given field.

In this way, the author also creates certain information in the ~~bar code~~ <u>barcode</u> area that can be unique to the document. The use of the building blocks, such as functions like drawcodeword and drawElement, ensures that the added information does not affect later decoding. It will be understood that other ways of programming may be provided, for example by providing different functions or different parameters to specify the additional information.

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Highly structured forms of editing may be used, for example calling only for entry of a string that has to be human recognizable in the ~~bar-code~~ barcode, in which case the authoring software takes care that the embedded program is arranged in such a way that the specified string will be recognizable. Alternatively, less structured forms may be used, which provide more varied control over the embedded program.